REMARKS

Claims 1-5 and 8 have been amended and new claims 27-38 have been added. Claims 6, 7, and 9-19 were withdrawn from consideration by the Examiner. Claims 20-26 are withdrawn. The specification has been amended to provide verbatim language for the term "outer wires" used in claims 2, 4, support for which is provided in Figures 6A-6C.

New claim 27 claims the orientation of the wires embedded into the adhesive layer, support for which is provided in Figure 1 and related description.

New claim 28 claims another orientation of the wires embedded into the adhesive layer, support for which is provided in Figures 9A and 9B, and related description.

New claim 29 claims an orientation of outer wires, support for which is provided in Figures 6A-C, and related description.

New claim 30 claims that outer wires are soldered to the wires embedded into the adhesive layer, support for which is provided on p. 8 at line 27.

New claim 31 claims that the outer wires have portions embedded into the adhesive layer, support for which is provided on p.8 at lines 24-25.

New claim 32 claims that the adhesive layer has a thickness less than a thickness of wires embedded therein, support for which is provided on p. 9 at lines 13-14.

New claim 33 claims a first terminal bar electrically connected to said wires embedded into said adhesive layer and extending transversely thereto, support for which is provided in Figures 7 and 12 and related description.

New claim 34 recites an angularly formed terminal bar, wherein said wires embedded into said adhesive layer are connected to a first portion of said angularly formed terminal bar and said outer wires are connected to a second portion of said angularly formed terminal bar, support for which is provided in Figure 8 and related description.

New claim 35 recites a terminal bar having a longitudinal portion extending generally parallel to said wires embedded into said adhesive layer and a plurality of spaced apart transverse portions connected to said longitudinal portion and sufficiently spaced apart to receive a photovoltaic element between adjacent transverse portions, said wires embedded into said adhesive layer being connected to said transverse portions, support for which is provided on p. 11 at lines 10-15 in connection with Figure 10A.

New claim 36 recites that film is sufficiently thick to be drawn and to support said adhesive layer and wherein said film is sufficiently thin to have elasticity, support for which is provided on p. 9 at lines 17-20.

New claim 37 recites that the film has a thickness of between about 10 micrometers to about 50 micrometers, support for which is provided on p. 9 at lines 20-21.

New claim 38 recites that the coating is on the entire surfaces of said wires operable to contact the electrically conductive surface of the photovoltaic element, support for which is provided on p. 6 at the end of the first paragraph.

The new claims capture the subject matter of original claims 3 to 5 in a different form and claim some additional subject matter.

Election/Restrictions

The Examiner has not found the applicant's remarks about the features that distinguish over Little to be persuasive for three reasons. Firstly the Examiner equates a thin plate to a thick film. Applicant respectfully submits that one of ordinary skill in the art would understand the difference between a film and plate especially in the context of applicant's disclosure and the disclosure of Little and therefore the wording of applicant's claim on its face distinguishes over the plate of Little. Secondly, the Examiner appears to believe the softened antireflective coating of Little acts as an adhesive layer. It does not. The antireflection coating described by Little is never described to have adhesive properties. Furthermore, for the coating described by Little to have antireflective properties it must adhere to the formula $S = \lambda/n*4$ where S=thickness, λ=wavelength of light and n=refraction index of material. According to Little n=2.2 (Column 12, line 15) If the wavelength of light is 0.5 microns, the thickness of the antireflective coating of Little must be about 0.06 microns. In the context of applicant's disclosure, for a wire to be embedded into such a layer the wire would have to be on the order of the same thickness and such a wire would not provide sufficient conductivity to be able to draw off the current generated by a typical photovoltaic cell. Thus, again, in the context of applicant's disclosure one of ordinary skill in the art would understand that the antireflective coating of Little would not work as a suitable adhesive layer in the application contemplated by the applicant. Thirdly, the Examiner stated it would have been obvious to use a solder coating to connect the wires to busbar 27, not to connect the grid to the cell. While this individual aspect by itself may or may not be obvious, it is respectfully submitted that in the context of applicant's claim as a whole, the whole claim is not rendered obvious by Little.

As for the Examiner's remarks under this heading in connection with EP 0 807 980 A2 applicant agrees that the claim language only requires the presence of the alloy on a part of the surfaces protruding from the adhesive layer. More detailed comments about how the invention distinguishes over this reference are

provided under the heading 35 U.S.C. § 103(a) below. Perhaps the Applicant's remarks below in response to the allegations of Obviousness in view of the cited references will further assist the Examiner in understanding the differences between the cited art and the applicant's claims.

Claim objections

The Examiner made certain objections to claims 1, 5 and 8 due to the inclusion of (wafer 3) and due to the spelling of the word "Center" in claim 8. Claims 1, 5 and 8 have been amended accordingly. Therefore applicant has overcome the Examiner's objections with respect to these claims.

35 U.S.C. § 112

The Examiner made certain objections under 35 U.S.C. § 112 to claims 1-5 and 8.

To deal with these objections, in all of claims 1-5 and 8, numerical references have been removed, as suggested by the Examiner. In claim 1, reference to the terminal bar has been made into a functional limitation rather than a direct recital of the terminal bar itself and extraneous words have been removed.

As for claim 2, clarity has been given to the recital of what was earlier referred to as the second plurality of wires. For greater consistency with the specification the first and second pluralities of wires are now referred to as "the wires embedded in the adhesive layer" and the "outer wires" respectively. (The specification defined the first plurality of wires as that which is coated and in direct contact with the surface or surfaces of the PV element to which the electrode is ultimately connected. (p 6, first paragraph)). In addition, the second terminal bar is no longer positively recited, but rather recited as a functional limitation on the outer wires.

The deletion of reference numerals addresses the Examiner's specific objection in this regard to claims 2-5 and 8.

In connection with claims 4 and 5, the term "bar(s)" has been replaced with the term "bars" for clarity.

In connection with claim 5, antecedent basis has now been provided for "contour" and the language relating to the bars being at opposite ends of the wires has been replaced with a reference to the bars being outside a contour of the photovoltaic element.

In connection with claim 8, the reference to Figure 16 has been deleted.

In view of the foregoing, applicant respectfully submits that all of the Examiner's objections under 35 U.S.C. § 112 have been overcome.

<u>35 U.S.C. § 103(a)</u>

The Examiner has rejected claims 1-5 under 35 U.S.C. § 102(b) as being unpatentable over Little (presumably US 4,380,112) in view of Shiotsuka (EP 0 807 980 A2).

The requirements for a *prima facie* case of obviousness have been well established by the Court of Appeals for the Federal Circuit, and are concisely summarized in M.P.E.P. § 2142 and 2143, which confirm that three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest *all the claim limitations*. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not

based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

While remarks have already been made as to how the applicant's claims distinguish over the cited references, Applicant respectfully submits that the cited references do not constitute a *prima facie* case of obviousness because there is no suggestion or motivation in the references themselves or in the knowledge generally available to one of ordinary skill in the art to modify either reference or to combine the teachings of the references, as such there is no reasonable expectation of success and not all of the claim limitations are taught or suggested by the references.

Applicant's claim 1 recites an adhesive layer on one surface of an electrically insulating optically transparent film, and a plurality of wires embedded into the adhesive layer. Applicant respectfully submits that none of the references cited above discloses or suggests an adhesive layer on one surface of an electrically insulating optically transparent film, and that none of the cited references discloses or suggests wires embedded into such an adhesive layer in the context of claim 1.

The Examiner has stated that that Little discloses an anti-reflective coating on one surface of a transparent cover plate (Column 7, lines 6-32), and Little discloses wires that are embedded into a softened inner surface of the plate (Column 7, lines 47-48). However, Applicant respectfully submits that Little fails to disclose or suggest *an adhesive layer* with wires *embedded into the adhesive layer*. More broadly, Little fails to disclose or suggest a layer with an adhesive property. Moreover, Little teaches away from an adhesive layer because Little discloses *electrostatic bonding* to hold a plate to a semiconductor wafer, which does not involve an adhesive layer. Also, Little discloses wires embedded into a softened inner surface of a plate (Column 7, lines 47-48), but the softened inner surface of a plate is not a layer that is separate with properties distinct from the

plate, so Little fails to disclose or suggest a layer for embedding wires that is separate from the transparent cover plate and has an adhesive property distinguishing it from the plate. Furthermore, the antireflective layer described by Little is not described as an adhesive layer, nor is there any suggestion or motivation to use it as an adhesive layer, not could it be used as an adhesive layer for the reasons given under the heading Election/Restrictions. Thus there is no motivation to modify the teachings of Little toward applicant's claimed invention and to modify the teachings of Little toward applicants claimed invention would be to radically alter the way the method described by Little operates. In summary, Little fails to disclose or suggest *a distinct layer with an adhesive property and into which wires are embedded.*

Shiotsuka et al. describes the use of a thermocompression treatment wherein electrically conductive adhesives on metalic wires are fused and solidified to accomplish electrical and mechanical connection of the metallic wires with a photovoltaic element and bus bars. Shiotsuka et al. however, fails to disclose that the wires are embedded into an adhesive layer on an electrically insulating optically transparent film.

In applicant's claim 1, adhesive is used to secure the wires to a surface of a film leaving some surface portions of the wires exposed. These exposed surface portions are coated with a low melting point alloy and it is this alloy that is used to secure the wires to the surface of the semiconductor.

In effect therefore, following the applicant's invention, the electrode of claim 1 can be pre-manufactured to include the wires and the optical film, the wires being secured to the optical film by the adhesive in a parallel spaced apart arrangement, for example. Pre-manufacturing can also involve coating exposed surfaces of the wires protruding from the adhesive with the low melting point alloy. An electrode of this construction enables a user to simply lay the electrode on the surface of the semiconductor such that the spaced apart wires already on the optical film are placed over a desired area of a surface of the semoconductor

and as the electrode is so placed, the adhesive on the optical film secures the optical film to the surface, thereby fixing the wires in place on the surface. A good ohmic contact between the wires and the semiconductor surface is then achieved by causing the low melting point alloy to melt under pressure, to thereby electrically and mechanically secure the wires to the semiconductor surface upon cooling.

Shiotsuka et al. does not describe exactly how the wires are placed in the desired spaced apart relation and there is nothing to suggest that any part of each wire should be affixed to an optical film by adhesive while another part of each wire is affixed to the surface of the semiconductor by a low melting point alloy.

Shiotsuka et al. describes the use of an adhesive to secure wires in the context of securing the ends of the wires to bus bars to maintain a desired interval between the bus bar and the photovoltaic element to protect it from burs or fractures on the metallic bus bar and to prevent metal ions from migrating into the power generation active area of the photovoltaic element that could cause a shunt to occur.

Figures 2(a) and 2(b) for example, are cross sectional views through the bus bar area.

Figures 3(a) and 3(b) illustrate that the connection of the wire to the semiconductor surface is by means of an adhesive and not a low melting point alloy and that there is no optically transparent film having an adhesive in which the wire is embedded. Such a film would have been shown above the wire, for example.

Clearly, Shiotsuka et al. relies on adhesive only to secure the wires to the surface of the semiconductor and to the bus bar. The only examples of securing the wire to the surface of the semiconductor involve adhesive and there is no suggestion to employ a low melting point alloy on one surface of the wire while another

surface of the wire is embedded in an adhesive secured to an optically transparent film.

Adhesives are usually less conductive than low melting point alloys and thus can give rise to greater resistive losses in collecting current from the semiconductor surface, than would be obtained using a low melting point alloy. Thus, the use of the low melting point alloy in applicant's invention provides for a better collection of current from the semiconductor surface, with fewer losses.

Directly securing a low melting point alloy to a surface of a semiconductor is difficult due to the smoothness of the semiconductor surface. However, in applicant's claims by using the optically transparent film to which the wires are adhesively secured, a mechanical connection is made between the film and the surface of the semiconductor, which serves to mechanically hold the wires in place on the semiconductor surface. While the wires will be mechanically held against or in close proximity to the semiconductor surface, it will be appreciated that no wire will be perfectly straight and therefore there may be some areas of the wires that are not in contact with the semiconductor surface, even though the film is adhesively secured to that surface and holding the wires against the surface. However, with the low melting point alloy on the exposed surface of the wires, when the low melting point alloy is heated and melts, any gaps between portions of the wires and the surface tend to be filled by the low melting point alloy to connect the entire exposed surface of the wire to the alloy, and thus to the semiconductor surface, to provide for a low resistance ohmic contact all along the entire length of the wire in contact with the semiconductor surface.

The use of the optically transparent film to support and mechanically hold the wire in place during heating of the low melting point alloy facilitates the use of a low melting point alloy in this application. While the use of low melting point alloys to secure wires to surfaces may have been known in the past, it appears the conventional wisdom has been to use a conductive adhesive, without an optically transparent film, to secure the wires to a semiconductor surface, as evidenced by all of the prior art cited by the Examiner, with the exception of the

Little reference, which uses a completely different process. It is thought that prior inventors have avoided the use of a low melting point alloy in this application because of the difficulty in placing the wires and holding them while the alloy is melted and cooled. The use of the optically transparent film and the wires adhesively secured thereto addresses this problem efficiently and inexpensively.

In addition to the advantages in reducing electrical losses through the use of the low melting point alloy as mentioned above, the use of such an alloy allows a photovoltaic cell employing the methods and apparatus claimed by the applicant to better withstand the high temperatures associated with exposure to the sun. For example, a semiconductor device may experience surface temperatures of 80 degrees Celsius, for example. This is well below the melting point (approx 90 – 110 degrees Celsius) of the alloy, whereas it is above the melting point of a typical adhesive. Therefore, a photovoltaic cell employing the low melting point alloy to secure the wires to the semiconductor surface permits the cell to withstand greater temperatures than a cell employing only adhesive to secure the wires to the semiconductor surface.

Shiotsuka et al. provides no motivation to use anything other than an adhesive to secure the wire to the surface of the semiconductor. Furthermore Shiotsuka et al. provides no motivation to employ an optical film and to secure the wires to the optical film using adhesive, while using a low melting point alloy instead of an adhesive to secure the wires to the surface of the semiconductor.

The method of securing taught by Shiotsuka et al. is completely different from that claimed in applicant's claim 1 and cannot achieve the advantages of reduced electrical losses and higher operating temperatures enjoyed by applicant's invention. More particularly, there is no teaching in the cited references alone or in combination, that would have prompted the skilled person, faced with the same technical problem to modify or adapt Little or Shiotsuka et al. to arrive at the invention claimed by the present applicant. Therefore it is respectfully submitted that the applicant's invention and more particularly amended claim 1 possesses an inventive step and is not obvious.

Claims 2-5 are directly or indirectly dependent upon independent claim 1. Applicant therefore respectfully submits that claims 2-5 are allowable due to their dependencies, as well as the additional subject-matter that each of these claims recites.

Nath & Ichinose

The Examiner has rejected claims 1-4 under 35 U.S.C. § 103(a) as being unpatentable over Nath et al in view of Ichinose et al.

The Examiner stated that Nath discloses thermoplastic layers (Column 5, line 62; Column 6, line 19) and Nath discloses metallic foils or wires adhered to a device by conductive adhesive (Column 5, lines 8-20). However, Applicant respectfully submits that Nath fails to disclose or suggest *an adhesive layer on one side of a film* with wires *embedded into the adhesive layer*. Nath fails to disclose or suggest an *adhesive* property of thermoplastic layers. Also, Nath fails to disclose or suggest that the conductive adhesive forms a *layer on one side of a film*. Moreover, Nath teaches away from an adhesive *layer on one side of a film* because Nath discloses a *conductive* adhesive. A *conductive* adhesive arranged as a layer on one side of a film, as recited in Applicant's claim 1, would short out the photovoltaic cell. In summary, Nath fails to disclose or suggest a *single layer on one side of a film with an adhesive property and into which wires are embedded.*

Ichinose discloses encapsulating a solar cell, and Ichinose discloses a metal wire coated with a conductive adhesive. However, Applicant respectfully submits that Ichinose fails to disclose or suggest an *adhesive layer on one surface of an electrically insulating optically transparent film wherein wires are embedded in the adhesive layer.*

From the foregoing, it should be appreciated that Nath and Ichinose fail to disclose or suggest various aspects of Applicant's amended claim 1, including but not limited to an adhesive layer on one surface of an electrically insulating optically transparent film, and a plurality of wires embedded into the adhesive layer. Accordingly applicant respectfully submits that claim 1 is not obvious and should be allowed.

Claims 2-4 are directly or indirectly dependent upon independent claim 1. Applicant therefore respectfully submits that claims 2-4 are allowable due to their dependencies, as well as the additional subject-matter that each of these claims recites.

Applicant wishes to thank the Examiner for the indication of allowable subject matter in claim 8.

New claims 27-38 add 12 more dependent claims to the application. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16, 1.17 and 1.18 which may be required during the entire pendency of the application, or credit any overpayment, to Deposit Account No. 501050. This authorization also hereby includes a request for any extensions of time of the appropriate length required upon the filing of any reply during the entire prosecution of this application.

Respectfully submitted,

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